A CYTOTAXONOMIC STUDY IN SOME SPECIES OF DROSERA

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The genus *Drosera* L. (family Droseraceae), with world-wide distribution, consists of approximately ninety species. About sixty species are concentrated in Australia. The basic classification of the family was established by Diels (1906) under the Englerian system. Behre (1929) tried to clarify relationships among the genera and species of the Droseraceae using karyological methods with a few species from *Dionaea* Ellis, *Drosera*, and *Drosophyllum* Link., but he found little evidence regarding relationships within the family. Although chromosome studies of some *Drosera* species have been made by various authors (e.g., Rosenberg, 1903, 1904, 1909; Shimamura, 1941; Wood, 1955; Kondo, 1966, 1969, 1970, 1971a, 1971b, 1971c, 1973), many more chromosome data are necessary to justify Diels' classification of the Droseraceae biosystematically, and to clarify species relationships.

The chromosome numbers of six species of *Drosera* are here reported for the first time. Two cytotypes of *Drosera spathulata* Labill. listed here differ from those which have been published previously (Kondo, 1971b). Also, cytotaxonomic relationships in *Drosera* are reviewed and discussed in relation to Diels' classification of *Drosera* (1906).

MATERIALS AND METHODS

Materials used in this study were acquired from the following sources:

Drosera cuneifolia L. f. — cultivated by J. A. Mazrimas, Livermore, California (native to Capeland, South Africa). The voucher specimen is deposited in the Herbarium of Kondo Collection, Nagoya.

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Drosera gigantea Lindl. — cultivated by J. A. Mazrimas (native to Western Australia, Australia). The voucher specimen is deposited in the Herbarium of Kondo Collection, Nagoya.

Drosera hamiltonii C. Andrews — cultivated by J. A. Mazrimas (native to Western Australia). The voucher specimen is deposited in the Herbarium of Kondo Collection, Nagoya.

Drosera neocaledonica Hamet — cultivated by J. A. Mazrimas (native to New Caledonia). The voucher specimen is deposited in the Herbarium of Kondo Collection, Nagoya.

Drosera petiolaris R. Br. — cultivated by J. A. Mazrimas (native to Western Australia, Northern Territory, and Queensland, Australia, and New Guinea). The voucher specimen is deposited in the Herbarium of Kondo Collection, Nagoya.

Drosera spathulata Labill. The Kanto cytotype — Ichimiya, Ichimiya-cho, Chosei-gun, Chiba Prefecture, Kanto District, Japan (collected by *S. Mori,* s.n., May 1973; sent by I. Kusakabe, Tokyo). The Yakushima cytotype — Yakushima Is., Kyushu District, Japan (collected by *K. Suzuki,* date unknown; sent by I. Kusakabe). The voucher specimens are deposited in the Herbarium, Department of Botany, The University of North Carolina, Chapel Hill (NCU).

Drosera adelae F. Muell — cultivated by D. E. Schnell, Statesville, North Carolina (native to a small area in Queensland, Australia). The voucher specimen is deposited in the Herbarium of Kondo Collection, Nagoya.

Root tips were fixed in Farmer's fluid. Chromosome preparations were made by the acetocarmine squash method. The symbols for the karyotype descriptions for *Drosera* are as follows: L = long chromosomes (longer than 2.5 μm), M = medium chromosomes (2.4-1.0 μm), S = short chromosomes (shorter than 1.0 μm), and sm = submedian constrictions.

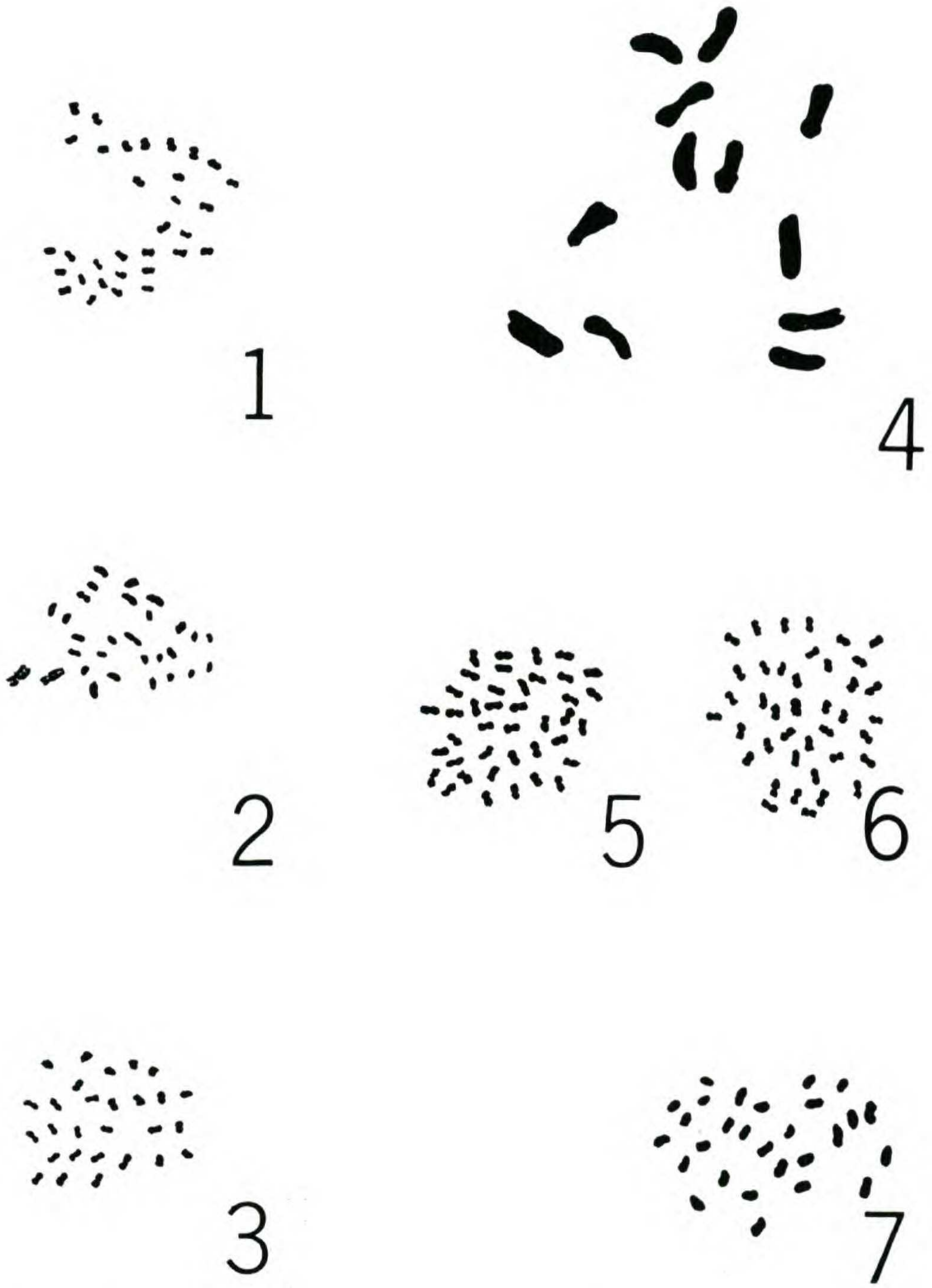

Fig. 1-7. Somatic chromosomes (x ca. 1450) of six species of *Drosera:* 1. *Drosera cuneifolia* L. f. ($2n = 32$); 2. *Drosera gigantea* Lindl. ($2n = 28$); 3. *Drosera hamiltonii* C. Andrews ($2n = 28$); 4. *Drosera petiolaris* R. Br. ($2n = 12$); 5. *Drosera spathulata* Labill. (Kanto cytotype; $2n = 40$); 6. *Drosera spathulata* Labill. (Yakushima cytotype: $2n = 40$); 7. *Drosera adelae* F. Muell. ($2n = 28$).

RESULTS AND DISCUSSION

Drosera cuneifolia has the somatic chromosome number $2n = 32$ (Fig. 1). The karyotype of the species is K ($2n = 32$) = 32S. Most of the chromosomes are the same in size (Fig. 9). Since the karyotype of the species is symmetrical in the tetraploid type, the basic chromosome number of it may be $x = 8$. This species is placed in subgenus *Rorella,* section *Rossolis,* series *Eurossolis* (Table 1). Species studied in this series show a basic chromosome number $x = 10$, which is different from that of *D. cuneifolia* ($x = 8$).

Drosera neocaledonica and *D. spathulata* are also placed in the same section as the above. The karyotype of *Drosera neocaledonica is* K ($2n = 40$) = 40S. Most of the chromosomes are the same in size. Two cytotypes of *Drosera spathulata* (the Kanto cytotype, and the Yakushima cytotype) show the same somatic chromosome number: $2n = 40$ (Fig. 5, 6). The karyotypes of both cytotypes of *Drosera spathulata* are identical: K ($2n = 40$) = 40M. The idiograms of *Drosera spathulata* (Fig. 13, 14) show all the chromosomes for both cytotypes as essentially the same in size. The karyotypes and chromosome numbers presented here are the same as those reported for Australian tetraploid *Drosera spathulata.* The karyotype symmetry indicates that these three cytotypes, the Kanto cytotype, the Yakushima cytotype, and the Australian tetraploid cytotype, have an autotetraploid origin. Among the cytotypes of *Drosera spathulata,* the tetraploid cytotype might have the greatest distribution in Asia and Australia. These karyotypes and chromosome numbers are quite different from those of the Kansai cytotype of *Drosera spathulata,* in which K ($2n = 60$) = 18L + 42S (Kondo, 1973). The Kansai cytotype of *Drosera spathulata* might be an allohexaploid. Thus, in Japan there are three cytotypes of *Drosera spathulata,* the Kansai cytotype, the Kanto cytotype, and the notable Kobayashi's *D. spathu-*

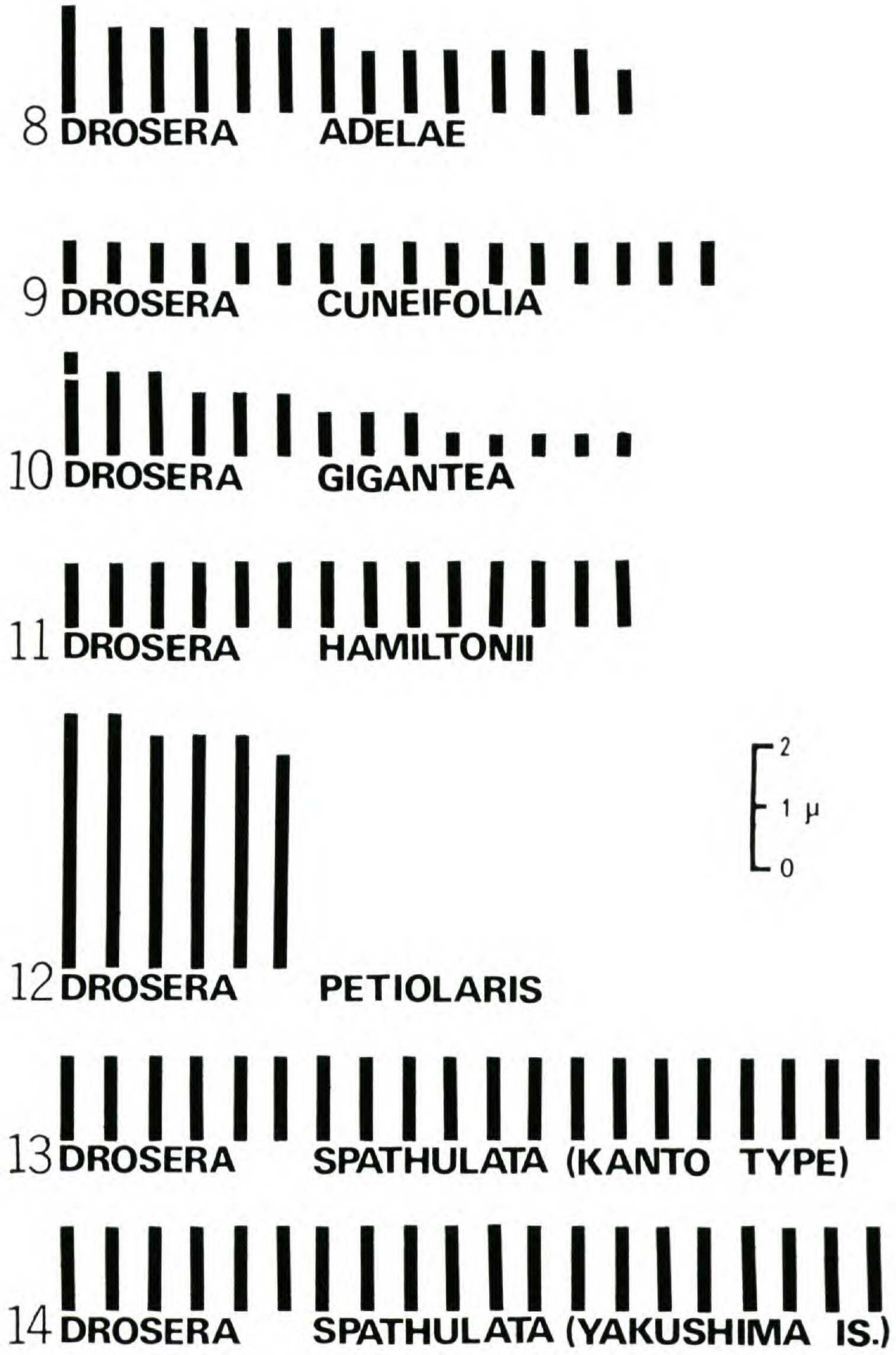

Fig. 8-14. Idiograms of six species of *Drosera:* 8. *Drosera adelae* F. Muell; 9. *Drosera cuneifolia* L. f.; 10. *Drosera gigantea* Lindl.; 11. *Drosera hamiltonii* C. Andrews; 12. *Drosera petiolaris* R. Br.; 13. *Drosera spathulata* Labill. (Kanto cytotype); 14. *Drosera spathulata* Labill. (Yakushima cytotype).

lata of hybrid origin (Kobayashi, 1950). The basic chromosome number x = 10 is typical of series *Eurossolis.*

Drosera gigantea, D. hamiltonii, and *D. adelae* show the same somatic chromosome number $2n = 28$ (Fig. 2, 3, 7). The karyotypes of the three species are as follows: *Drosera gigantea,* K $(2n = 28) = 2M^{sm} + 4M + 22S$; *D. hamiltonii,* K $(2n = 28) = 28S$; and *D. adelae,* K $(2n = 28) = 14M + 14S$.

Although the chromosome numbers of these three species are the same, their karyotypes differ and this indicates that each is of a distinct series. The karyotype of *Drosera gigantea,* which is symmetrical (Fig. 10) as a diploid, suggests it is a diploid series originating from an allotetraploid form, and its basic chromosome number might be x = 14. The basic chromosome number of *Drosera hamiltonii* might be x = 7, since its karyotype is symmetrical (Fig. 11) as a tetraploid. *Drosera adelae* shows a very symmetrical karyotype as a diploid (Fig. 8), and its basic chromosome number might be x = 14, instead of x = 7. *Drosera indica,* which is closely related to *D. adelae,* has fourteen bivalent chromosomes in meiosis (Kondo, 1966). This evidence suggests that the basic chromosome number for both *Drosera adelae* and *D. indica* might be x = 14. Thus, *Drosera gigantea* is placed in subgenus *Ergaleium,* section *Polypeltes,* for which the basic chromosome numbers 8, 10, 13, and 14 have been reported; *D. hamiltonii,* in subgenus *Rorella,* section *Stelogyne,* which has the reported basic chromosome number x = 7 (or 14); and *D. adelae,* in subgenus *Rorella,* section *Arachynopus,* which has the reported basic chromosome number x = 14.

Drosera petiolaris showed the largest chromosomes (Fig. 12; K $(2n = 12) = 12L$) which have ever been seen in the genus *Drosera,* and the somatic chromosome number is $2n = 12$ (Fig. 4), which is the lowest number in the genus. This is interesting because this number is the same as that of *Drosophyllum lusitanicum* Link. of the Droseraceae ($2n = 12$; Rothfels, *et al.,* 1968).

Table I. Basic chromosome numbers studied and Diels' classification of *Drosera*

Taxa	Basic chromosome number
Drosera	
Subgenus I. *Rorella* DC.	
Section I. *Psychophila* Planch.	10
Section II. *Bryastrum* Planch.	unknown
Section III. *Lamprolepis* Planch.	unknown
Section IV. *Thelocalyx* Planch.	10
Section V. *Coelophylla* Planch.	unknown
Section VI. *Arachynopus* Planch.	14
Section VII. *Rossolis* Planch.	
Series I. *Eurossolis* Diels	8, 10
Series II. *Lasiocephala* Planch.	6
Section VIII. *Stelogyne* Diels	7
Section IX. *Phycopsis* Planch.	8
Subgenus II. *Ptycnostigma* Planch.	
Section X. *Ptycnostigma* Planch.	unknown
Subgenus III. *Ergaleium* DC.	
Section XI. *Polypeltes* Diels	8, 10, 13, 14
Section XII. *Erythrorrhiza* Planch.	7 or 14

Table I shows the basic chromosome numbers reported for the sections and series in Diels' classification of *Drosera.* The basic chromosome number $x = 10$ is more common, being found in four of the sections studied and in a polyploid series in *Drosera.* Although *Drosera cuneifolia* is placed in subgenus *Rorella,* section *Rossolis,* series *Eurossolis,* which is mostly a polyploid series with the basic chromosome number of ten, it has the somatic chromosome number $2n = 32$. Thus, the chromosome number of *Drosera cuneifolia* might have originated from the basic chromosome number of ten by some kind of chromosome aberration ($2n = 30 + 2$). Subgenus *Rorella,* section *Rossolis,* series *Lasiocephala* is represented by *Drosera petiolaris,* which has the lowest chromosome number, $2n = 12$, and larger chromosomes in size than those of any other species in the genus. However, this suggests that this species might be the most primitive species in the genus. The basic chromosome number $x = 7$ is found in one section, subgenus *Rorella,* section *Stelogyne,* which is closely related to section *Rossolis.* The basic chromosome number $x = 7$ might have originated from $x = 6$. In contrast, the section *Arachnopus,* which is considered to be morphologically more primitive than some other sections, has the basic chromosome number $x = 14$ which might have originated as an allotetraploid form; in other words, the basic chromosome number $x = 14$ might result from a hybrid origin ($8 + 6$).

Drosera pedata Pers. has the somatic chromosome number $2n = 32$ and the basic chromosome number $x = 8$. This binomial is a synonym of *Drosera binata* Labill. which belongs to subgenus *Rorella,* section *Phycopsis* (Diels, 1906). The somatic chromosome number of *Drosera binata* is $2n = 46$ which is quite different from that of *D. pedata.* However, the somatic chromosome number $2n = 46$ of *Drosera binata* might be the result of a hybrid origin (Sato, 1948; $32 + 16$) and reduction (Kress, 1970; $48 - 2$). Thus, the basic chromosome number of section *Phycopsis* might be $x = 8$. Sato (1948) also states that the chromosome number of *Drosera regia* Stephens ($2n = 34$) might be of hybrid origin, but it would be more natural to consider that the chromosome number of *D. regia* might have originated from chromosome doubling ($8 \times 2 = 16$) and increase ($16 + 1 = 17$) since hybridization between *D. regia* and other species is almost impossible. Subgenus *Ergaleium,* section *Polypeltes* which has various basic chromosome numbers ($x = 8, 10, 13, 14$), indicates this group might not be stabilized yet, with aneuploidy more common than in the other groups. The basic chromosome number $x = 14$ might be an allotetraploid source, and x = 13 might have originated from 14 by chromosome reduction.

Additional cytological observations of other species of *Drosera* could be expected to improve our concept of the interrelationships among species of *Drosera*.

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